

Proton and Deuteron  
Spin Structure Function Measurements  
in the Resonance Region

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for the RSS Collaboration

## Outline

- Overview
- Setup
- Results

## Overview

Jlab Experiment E01-006 (RSS):

- \* nucleon spin structure measurement  
 *$A_{\parallel}$  and  $A_{\perp}$ , proton and deuteron*
- \* scattered polarized  $e^{-}$  beam off polarized, solid target
- \* inclusive measurement
- \* Resonance Region ( $0.8 < W < 1.9 \text{ GeV}$ )  
 *$E_0 = 5.76 \text{ GeV}$ ,  $p = 4.09 \text{ GeV}$  and  $4.7 \text{ GeV}$*
- \* ran January – March 2002  
in Hall C at Jefferson Lab  
*Newport News, Virginia*
- \*  $\mathcal{P}_{ND_3} \approx 15\%$  and  $\mathcal{P}_{NH_3} \approx 70\%$   
*20 – 40 mC per target, orientation*

## RSS Collaboration

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## Motivation

Resonance Region Spin Structure Function Data:

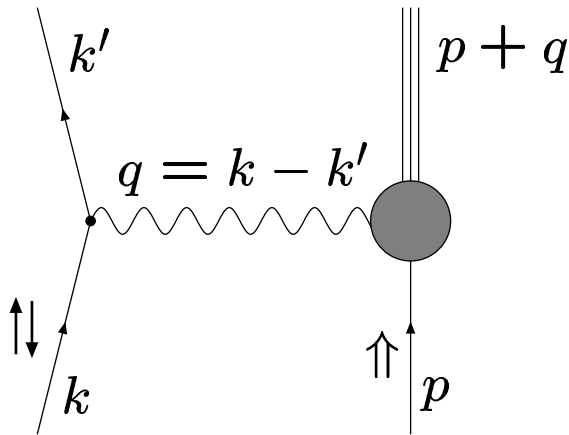
- \*  $W$  dependence of  $A_1$ ,  $A_2$
- \* (polarized) local duality
- \* GDH sum rule
- \* higher twist effects

RSS in particular:

- \*  $p$  and  $d$
- \*  $A_{\parallel}$  and  $A_{\perp}$
- \* consistent setup  
*same kinematics, systematics*

⇒ model-free extraction of  $A_1$  and  $A_2$

## Polarized Scattering



$$A_{\parallel} = \frac{\sigma^{\downarrow\uparrow} - \sigma^{\uparrow\uparrow}}{\sigma^{\downarrow\uparrow} + \sigma^{\uparrow\uparrow}}$$

$$A_{\perp} = \frac{\sigma^{\uparrow\leftarrow} - \sigma^{\downarrow\leftarrow}}{\sigma^{\uparrow\leftarrow} + \sigma^{\downarrow\leftarrow}}$$

$$A_1 = \frac{\sigma_{1/2}^T - \sigma_{3/2}^T}{\sigma_{1/2}^T + \sigma_{3/2}^T}$$

$$A_{\parallel} = D (A_1 + \eta A_2)$$

$$A_2 = \frac{\sigma_{1/2}^{TL}}{\sigma_{1/2}^T + \sigma_{3/2}^T}$$

$$A_{\perp} = d (A_2 - \zeta A_1)$$

$$g_1 = \frac{F_1}{1 + \gamma^2} (A_1 + \gamma A_2)$$

$$g_2 = \frac{F_1}{1 + \gamma^2} (A_2 / \gamma - A_1)$$

$$D = \frac{1 - E'\epsilon/E}{1 + \epsilon R}$$

$$d = D \sqrt{\frac{2\epsilon}{1 + \epsilon}}$$

$$\eta = \frac{\epsilon \sqrt{Q^2}}{E - E'\epsilon}$$

$$\zeta = \frac{\eta(1 + \epsilon)}{2\epsilon}$$

$$Q^2 = -q^2$$

$$\gamma^2 = \frac{Q^2}{\nu^2}$$

$$\epsilon^{-1} = 1 + 2(1 + \frac{\nu^2}{Q^2}) \tan^2(\frac{\theta}{2})$$

## From Experimental to Physical Asymmetry (simplified)

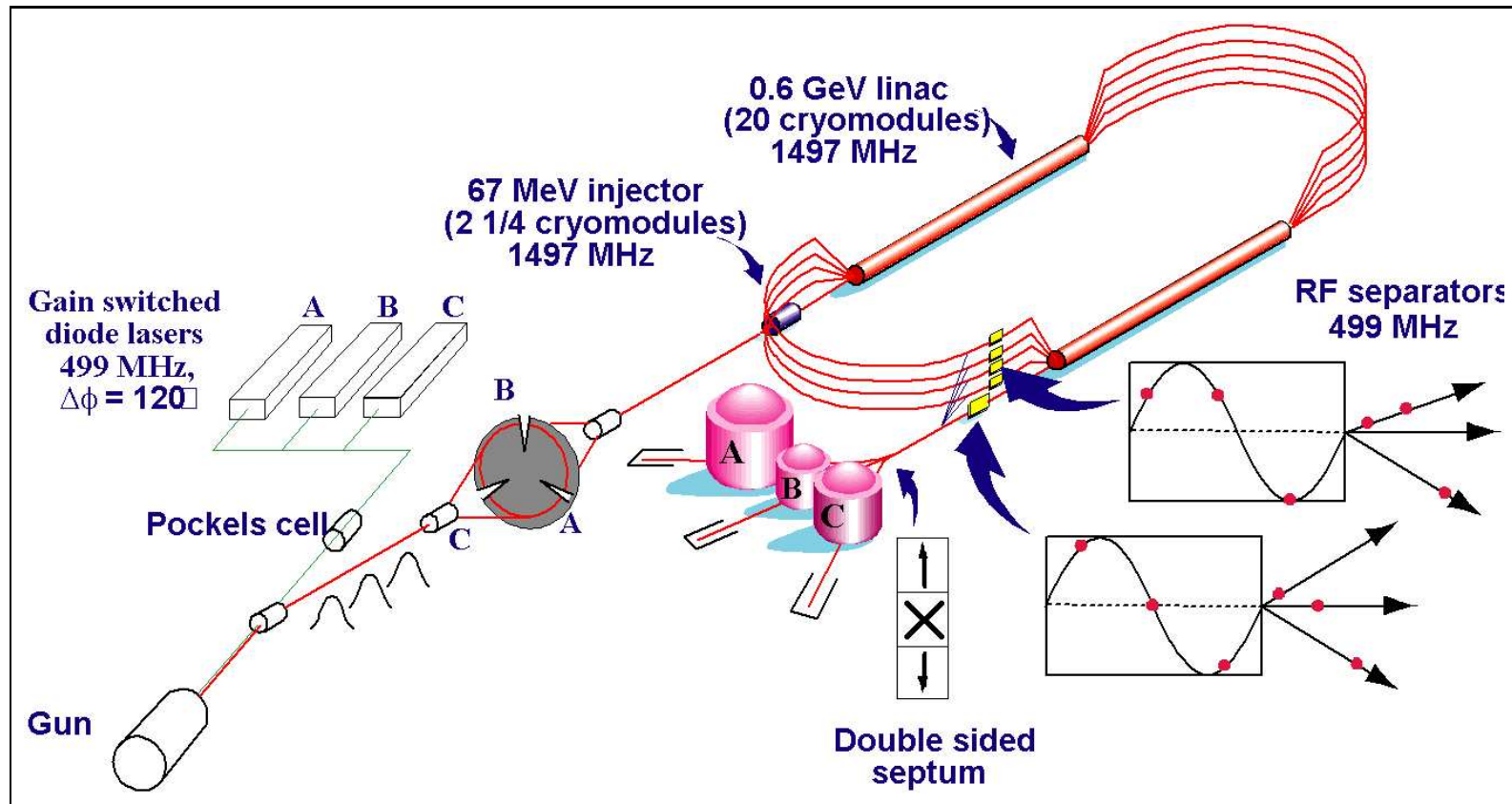
$$A_{raw} = \frac{N_{\downarrow\uparrow} - N_{\uparrow\uparrow}}{N_{\downarrow\uparrow} + N_{\uparrow\uparrow}}$$

charge normalized:  $N^i \rightarrow N^i/Q_i$

$$A_{\parallel}, A_{\perp} = \frac{A^{raw}}{f \mathcal{P}_{beam} \mathcal{P}_{target}} + A_{RC}$$

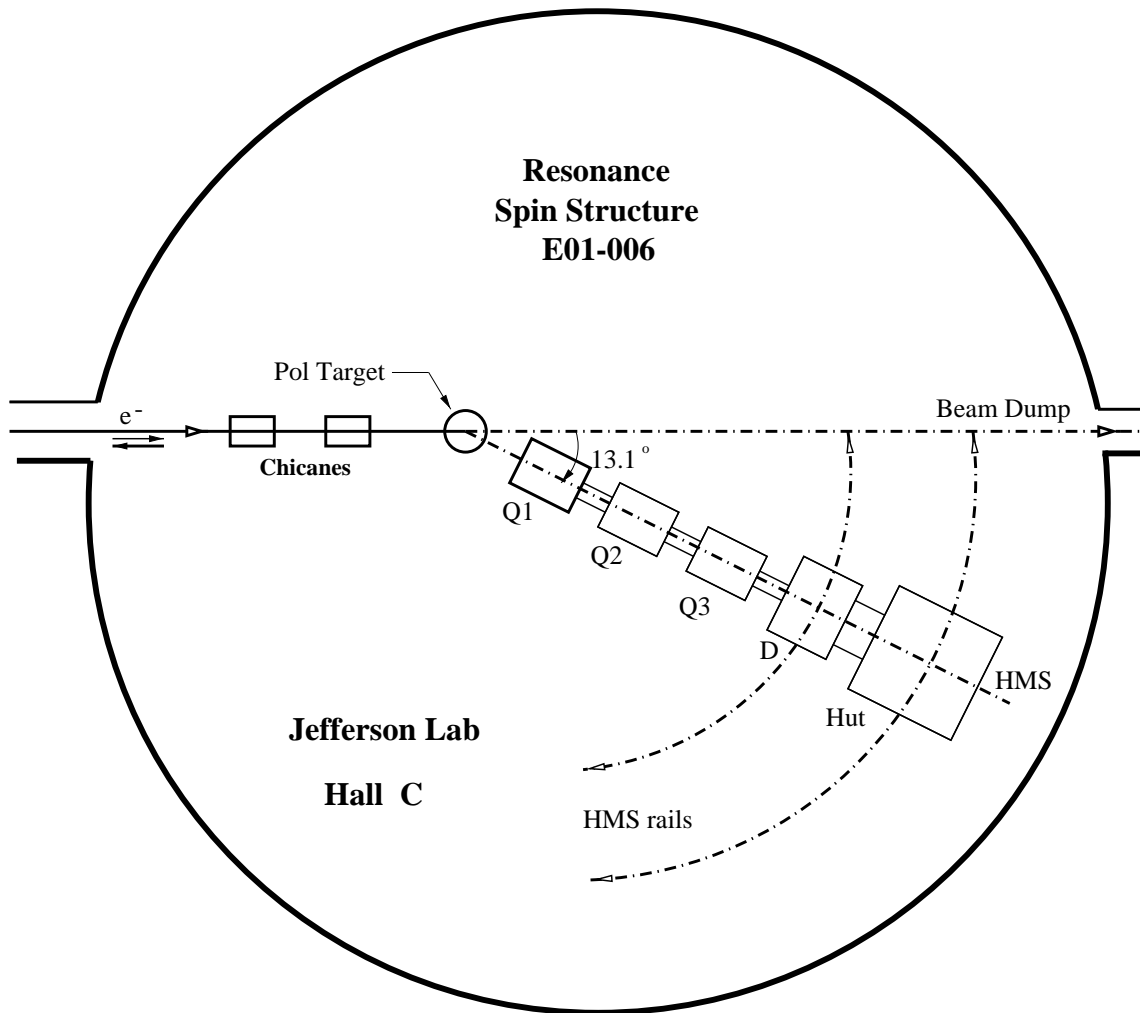
$\mathcal{P}_{beam}$	Beam Polarization
$\mathcal{P}_{target}$	Target Polarization
$f$	Dilution Factor
$A_{RC}$	Radiative Corrections

# Experimental Setup



Thomas Jefferson National Accelerator Facility

## Jefferson Lab's Hall C

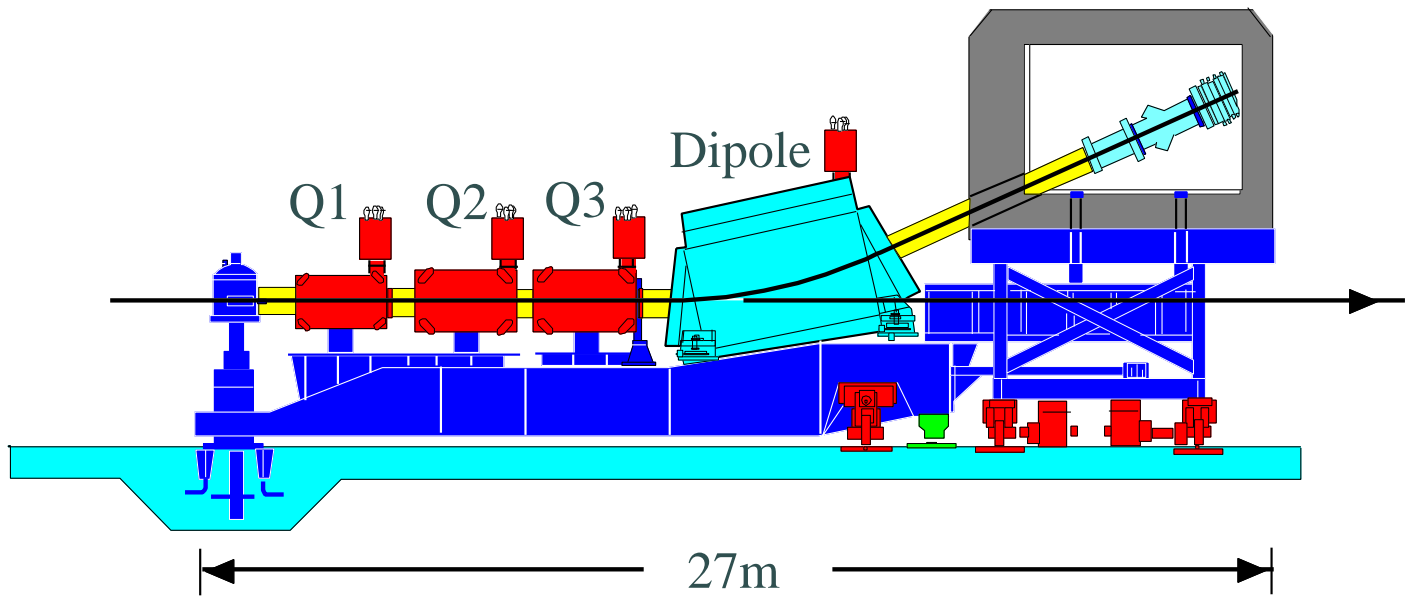


Not Shown:

- \* Moller Polarimeter
- \* Short Orbit Spectrometer
- \* recent G0 installations



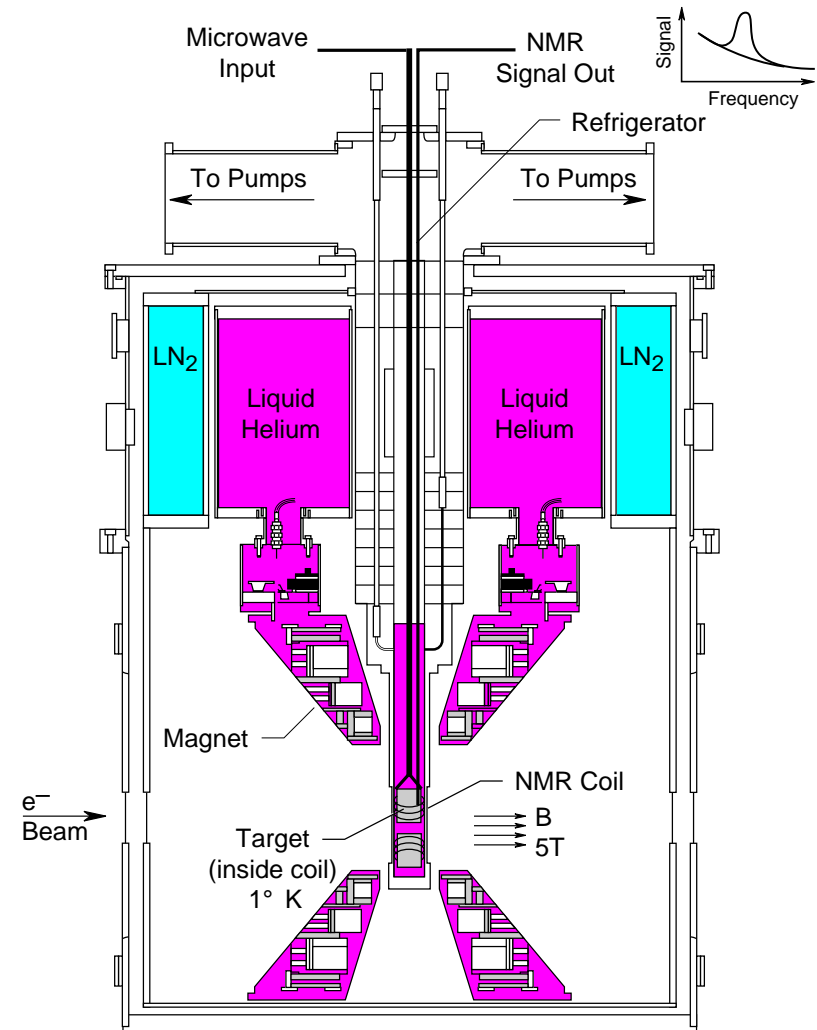
## High Momentum Spectrometer



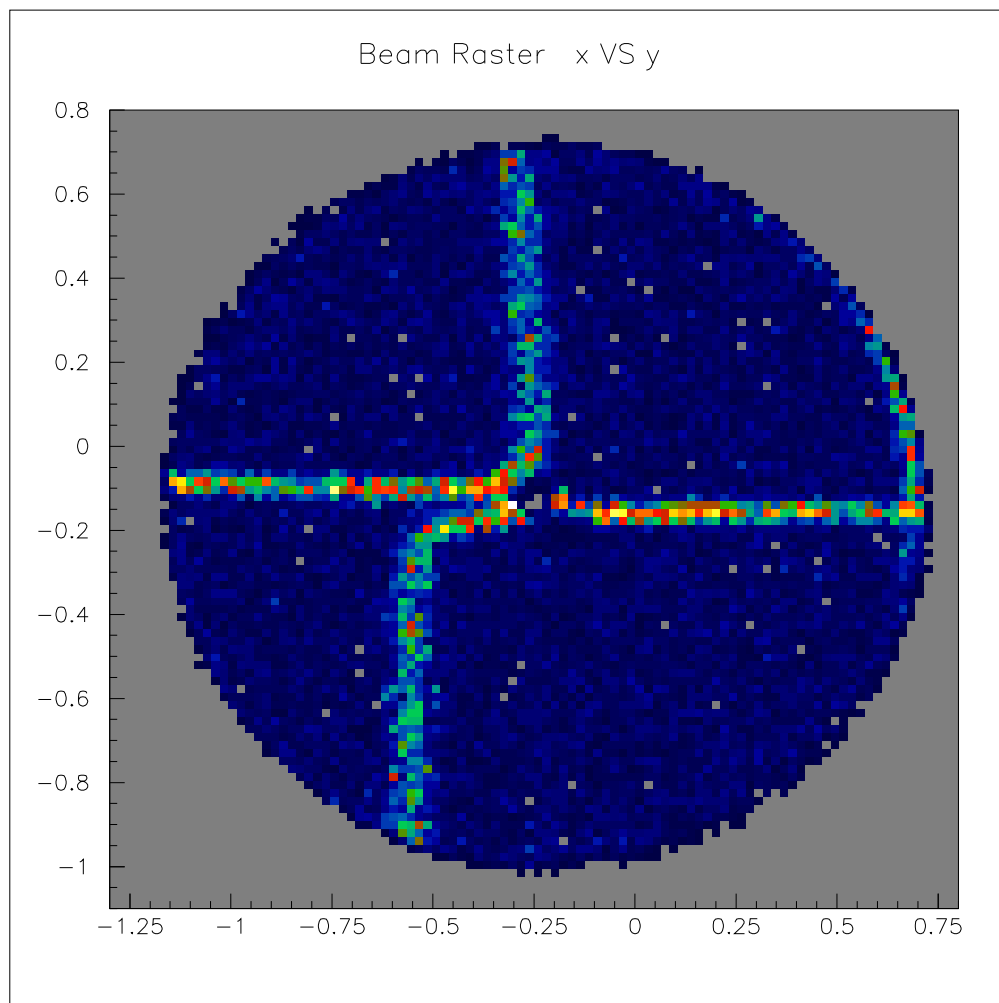
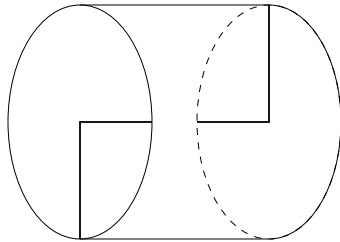
- \* 1 dipole magnet, 3 quadrupoles  
*4.1 and 4.7 GeV,  $\pm 9\%$  acceptance*
- \* shielded detector package  
*segmented Pb glass calorimeter,  
gas Cherenkov, scintillator hodoscopes,  
wire drift chambers*
- \* well-studied tracking, reconstruction

## Target

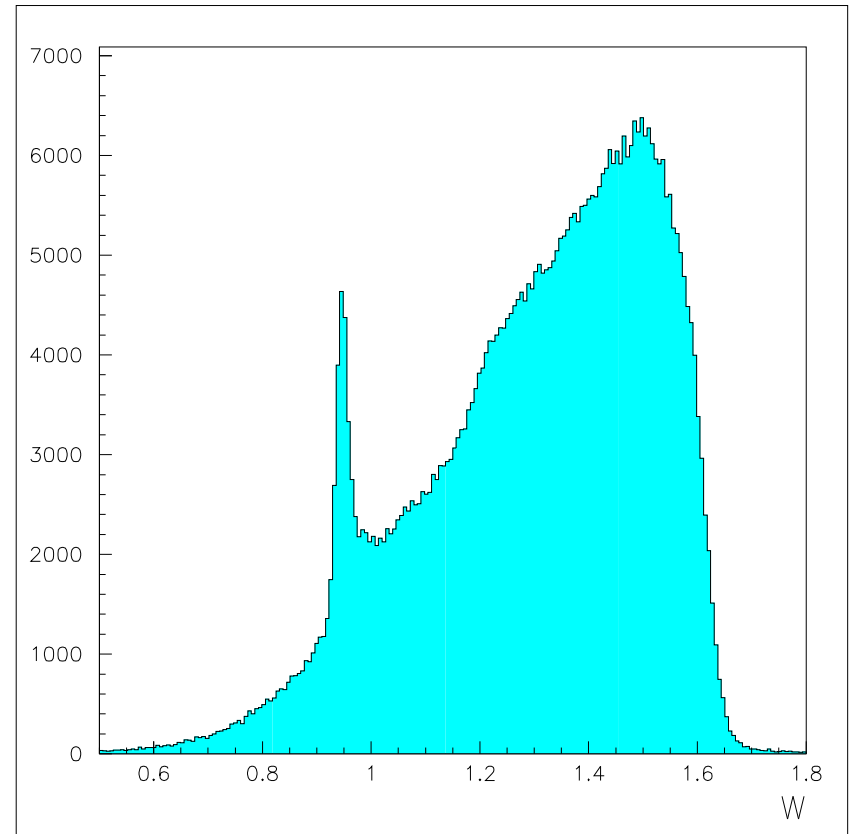
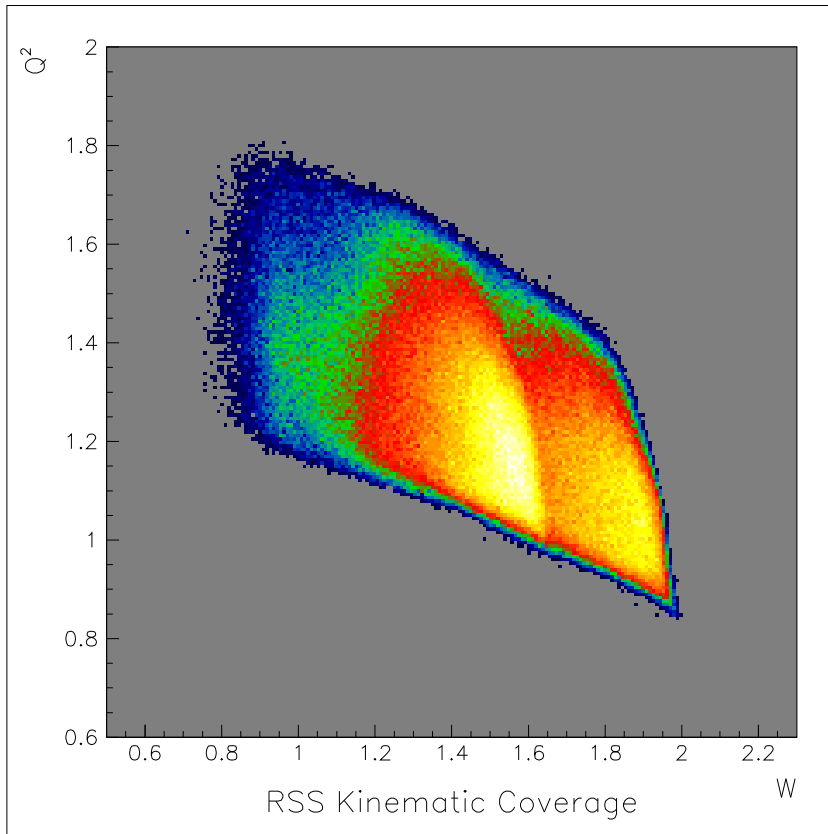
- \* frozen  $\text{NH}_3$  &  $\text{ND}_3$
- \*  $^4\text{He}$  evaporation refrigerator
- \*  $5T$  polarizing field
- \* dynamic nuclear polarization driven by microwaves
- \* NMR system for polarization measurement
- \* remotely movable insert



# Beam Rastering



# Kinematics



Example: longitudinal  $NH_3$

# Preliminary Results

